Robert L. Bates

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THE ASSOCIATION OF GEOLOGY TEACHERS

The ASSOCIATION OF GEOLOGY TEACHERS was founded in the Middle West in May, 1938. In November, 1951, it was organized as a national association, under which there are at present five organized regional sections: Central, East Central, Eastern, New England, and Far Western. A Southeastern Section will be organized in the near future. An annual meeting of the national association is normally held in the fall, and sectional meetings are held in the spring.

The purpose of the Association, as stated in its Constitution, is "to foster improvement in the teaching of the earth sciences at all levels of formal and informal instruction, to emphasize the cultural significance of the earth sciences, and to disseminate knowledge in this field to the general public."

Anyone concerned with geological education, formal or informal and at any age level, is invited to apply for membership. *Inquiries should be addressed to the national secretary:*

ROBERT L. BATES, Department of Geology
Ohio State University, Columbus 10, Ohio

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C. G. HIGGINS, Department of Geological Sciences
University of California, Davis, California

Submit all manuscripts to the editor:
ANASTASIA VAN BURKALOW, Department of Geology and Geography
Hunter College, 695 Park Avenue, New York 21, New York

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EDITORIAL: EARTH SCIENCE REQUIREMENTS FOR TEACHING GENERAL SCIENCE IN HIGH SCHOOL

Members of this Association know to their sorrow that Earth Science is not offered widely in the high schools in most parts of our country. However, a significant amount of Earth Science is included in most courses in General Science, which is now so omnipresent. Thus we still have a foothold in the secondary schools, and it is vitally important that we realize this and pay some attention to the training required of teachers of General Science. There is little doubt that they will have studied Chemistry, Physics, and Biology, and certainly geologists should not ask that any one of these be omitted. But they *should* ask that Earth Science be included in the course of study. In how many states is any branch of Earth Science specifically required? Each member of AGT should inform himself about the situation in his own state. Where it is not satisfactory, there are several procedures open to us: (1) Urge revision of the state law, and if that is undertaken make every effort to introduce required training in Earth Science.(2) If such revision is impossible for the present, work at the level of the college curriculum, which can usually be made to include more than is required by state law. Thus prospective teachers of General Science can be offered a curriculum that includes some study of the Earth Sciences. If that is not possible immediately, try at least to incorporate in the description of the curriculum a strong recommendation that Earth Science be taken. When both advice and compulsion are lacking, many students will fail to elect Earth Science because they are ignorant of its importance to them.

We rejoice that there are still some opportunities for our high-school students to learn about the Earth—that is, there can be if their teachers have any Earth lore to pass on to them. Let us see to it that these opportunities are developed as fully as possible. What would the chemists, physicists, and biologists say if teachers were licensed to teach General Science without having had any training in their subjects? Shall the geologists be less awake to their responsibilities?

ANASTASIA VAN BURKALOW

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CURRENT TRENDS IN GEOLOGY AND THEIR RELATIONS TO GEOLOGICAL EDUCATION

Leland Horberg
University of Chicago

ABSTRACT. The following six trends in American geology are discussed: (1) Diversification of geology into specialized sub-sciences. (2) Adoption of the methods and viewpoints of related basic sciences. (3) Expansion of geological research. (4) Vocationalism. (5) The increasing loss of geology teachers to industry and government organizations. (6) The great increase in enrollment of students in geology classes expected during the next few years. For the geology teacher these trends raise numerous problems. Some of the developments needed for their solution are: (1) A more conscious effort to unify the subject matter of geology and to define more clearly the concepts basic to general geology. (2) Provision for training both specialized and general geologists. (3) An increase in the number of grants available for individual research as opposed to directed research and large group projects. (4) A decrease in the teaching of applied geology. (5) Greater efforts—on the part of college and university administrations, government agencies, and private industries—to keep geology teachers teaching. (6) Closer cooperation in the teaching field to avoid duplication of effort, as between undergraduate and graduate departments and between graduate schools. (7) More rigorous scholastic standards for the geology major.

The subject is education, and even when confined to geological education, there are few other subjects which are so confusing and endless. Nevertheless, current educational issues are of major concern to this Association and it is appropriate that I venture to present some of them to you. Within the last few years our organization has indeed become national in scope and the responsibilities of the national organization in terms of aims and policies have increased correspondingly. The time is here, I believe, when greater attention should be given to the broader problems of geological education and the evaluation of the content of geology and less attention to teaching methods and techniques. In the present discussion attention will be confined to current trends in American geology and the educational problems which evolve from them.

Any attempt to formulate trends in a science as diversified as geology is largely a matter of personal judgement and the conclusions of different individuals certainly would vary widely. Thus the trends selected for review are incomplete and interrelated as well as controversial. They are as follows:

1. Diversification of geology into specialized sub-sciences.
2. Adoption of the methods and viewpoints of related basic sciences.

*Presidential address presented at the 1954 annual meeting of the Association of Geology Teachers, on January 28, 1955, at Ohio State University, Columbus.

3. Expansion of geological research.
4. Vocationalism.
5. The increasing loss of geology teachers to industry and government organizations.
6. The great increase in enrollment of students in geology classes expected during the next few years.

DIVERSIFICATION

Diversification of geology into what might be termed specialized subsciences is a normal development in the growth of any branch of knowledge and is especially true of geology—nor is it a new development in geology. However, it is apparent that this trend has become more and more pronounced during the last 10 to 15 years. It is indicated by such designations as: Earth Sciences, Marine Geology, Subsurface Geology, Airphoto Geology, Permafrost Geology and others; by new periodicals; and by the recent emphasis on the abstract journal and review papers. It has become increasingly difficult to communicate with geologists in other fields and there appear to be fewer and fewer common problems that can be discussed with colleagues down the hall. Less attention is being given to the broader problems of general geology and more to exact specialized knowledge. Along with this has been a tendency to de-emphasize the regional and historical aspects of geology.

There is no doubt but what diversification will continue and that through it and union with the basic sciences will come the major advances in our science. Yet it must be recognized that diversification in geology, as well as in other fields of knowledge, creates the necessity for unification and integration of subject matter. It requires that greater attention be given to the digestion and synthesis of a vast, growing literature and to the evaluation of concepts that are basic to general geology. Although geology is largely a dependent science, there are also central aspects, such as historical geology and field geology, that are distinctively "geology" and not shared with other sciences. These should be recognized as such, defined, and elaborated. Perhaps analysis of what concepts form the central core of geology is one of the most important first steps toward unification that can be taken.

In any attempts toward unification it is clear that the initiative will have to come largely from geology teachers—as individuals and through this Association. No other group is so directly concerned with the problems involved or so well qualified to handle them. Among geology teachers many in all groups will continue to concentrate on the broader prob-

lems of general geology. However, probably no other group is in a better position to make contributions than the teachers in small departments in liberal arts colleges. This group, which founded and carried our association forward, is particularly qualified by reason of experience in liberal education and in teaching a wide range of geological subject matter.

Specific suggestions as to what teachers can do toward unification remain to be formulated, but are indicated in part by the following: writing of reviews, abstracts, summary papers and books; compilation of summary maps and diagrams; revision of curricula, courses, and laboratory materials; and organization of discussions which would lead to clarification of the aims of geological education and the content of basic courses. From a negative point of view it is questionable whether our aims in introductory courses will be satisfied by either the history of science or the scientific method approach. The former fails to convey the content of modern geology and the latter is based on the dubious assumption that definable scientific methods distinctive of geology exist.

BASIC SCIENCE APPROACH

The adoption of the methods and viewpoints of the basic sciences undoubtedly has been the most important impetus toward diversification and it is considered separately only as a matter of convenience. Hence, many of the comments made previously apply here and need not be repeated. The trend is clearly indicated by the recent emphasis on: Geochemistry, Geophysics, Statistical Geology, Biogeochemistry, Isotope Geology, and others; by the increasing importance of laboratory investigations; and by the "quantitative" approach evident in recent textbooks.

There is little question but what this approach is now revolutionizing modern geology and that great progress has already been made. Certainly the labels, "bandwagon" and "fad," have no general validity. Yet it is important to recognize the educational problems and possible dangers that evolve from it. More specifically, there is reason to fear that specialized sub-sciences may become substitutes for rather than allies of general geology; that in extreme cases investigations may reach the point of becoming non-geological; that field training may be lost to a large number of geologists; and that important qualitative concepts may either be ignored or else needlessly elaborated in quantitative terms.

For geological education this trend again indicates the need for synthesis in terms of basic geology. It re-emphasizes the need for broadening the undergraduate curriculum in related basic sciences and mathematics.

It also suggests reduction of basic undergraduate courses and the desirability of a split into physical, biological and general geology groups at the undergraduate level.

The ramifications of the problem defy pursuit and for present purposes it is sufficient to note that both specialized and general geologists are needed and that provisions should be assured for the training of both groups.

EXPANSION OF GEOLOGICAL RESEARCH

Expansion of geological research in the last decade has resulted largely from increased appropriations of governmental funds to survey organizations, research agencies and the military. Additional funds have also become available to many private institutions. Among the pitfalls accompanying this fortunate circumstance are: the perils inherent in directed research; the tendency to direct major efforts toward applied research; the over-emphasis on large group projects involving many specialists; the neglect of the individual research worker and his personal qualifications; and the fallibility of committees responsible for the direction of funds.

These problems apply to geological education mainly by reason of the dependence of effective teaching on individual research. Research provides a stimulus to the scientific curiosity and enthusiasm, which, aside from natural talents, are essential to successful teaching. From this viewpoint our concern as geology teachers is largely with the problems of the individual research worker and the most important immediate aim is the provision for his needs. Under present economic conditions, unless individual research grants are available, many geology teachers will be forced to give up independent scientific investigations—and once the break is made it is likely that a large proportion will never return to them.

VOCATIONALISM

The issue of vocationalism is not as immediate as it once was and the heyday of courses in applied geology appears to be past. This change can be attributed in large part to the disappearance of the B.S. degree as a professional degree in commercial work and to a growing realization by industry that courses in basic geology and allied sciences are not only more important than applied courses but that a large part of "applied geology" can best be learned on the job. Unfortunately vocational courses are readily marketable and with increasing competition for students and the desire for shortcuts due to the draft there is a continuing tendency for them to multiply.

At present we are facing a period of increasing teaching loads. This is an imminent problem and it would appear that at least a partial solution would lie in the reduction of courses in applied geology.

LOSS OF GEOLOGY TEACHERS

The current crisis arising from the loss of geology teachers to industry and government organizations has been ably treated in a recent paper by John Lucke (1954) and I can only reaffirm his suggestions: (1) that college and university administrations must be made aware of the situation; (2) that government agencies "should liberalize their employment to enable many more teachers to do research on a temporary basis . . . "; (3) that the Defense Department "should alter the draft policies so as to maintain or preferably increase a continuing flow of highly trained professional geologists"; and (4) that private industries, especially the major oil companies, support the scientific activities of geology teachers in as many ways as possible.

FUTURE INCREASE IN ENROLLMENT

It is estimated that the total enrollment in colleges and universities will increase from about 2,500,000 as of 1950 to about 4,600,000 by 1960 (Griswold, 1954, p. 8). Press reports of initial surveys of enrollment for the current school year, which indicate an increase of about 8 per cent, confirm this trend. Although there are indications that the percentage increase of students in the sciences may fall below the total, the general situation is not altered significantly and it does not seem unreasonable to think in terms of a 60 to 70 per cent increase in geology students by 1960.

From this situation two principal effects on geological education are anticipated: (1) an intensification of the problem of teaching personnel and (2) an increase in competition in jobs for students. To some extent these two effects offset each other, but *in toto* it is unlikely that competition for jobs will alleviate teacher shortages unless there are major changes in the national economy. If this conclusion is valid, again it is the problem of geology teachers which is most critical.

In addition to Lucke's suggestions toward the solution to the problem, the following may merit further discussion: (1) reduction of course offerings in applied geology and, in undergraduate departments, elimination of those advanced courses which are commonly repeated in graduate work; (2) diversification among graduate schools so that there is less duplication of effort in specialized fields; (3) closer cooperation between undergraduate and graduate schools in the planning of programs; and (4) insist-

ence on more rigorous scholastic standards so that the number of geology majors can be held in check.

Contrary to geological custom, there will be no "summary of conclusions" to this paper and I will close by simply commending the problems discussed to the Association for more detailed consideration and action.

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TEACHING INDUSTRIAL MINERALS TO GEOLOGISTS

Joseph L. Gillson*
Wilmington, Delaware

ABSTRACT. The importance of the field of industrial minerals is emphasized and ways are suggested to make a course covering the broad subject stimulating and interesting.

In 1951 (the latest year for which published figures are complete), the value of all minerals produced in the United States was $13,524 million, of which fuels accounted for 72.3 per cent, non-metals 15.4 per cent, and metals 12.3 per cent. These figures show that the value of the non-metals is greater than that of the metals, but the importance of the non-metal industry is not appreciated by most geologists. In only 48 of the 210 colleges and universities in the United States and Canada in which a geology major is offered is a course given that is called Economic Geology of the Non-Metallics, or by some similar title. Except at a very few like the California Institute of Technology and Lehigh University the course offered is for only one semester and is for three or four hours of credit, or at Harvard and the University of British Columbia a "one-half unit," which seems to mean two hours per week. In many of the courses the industrial minerals are included with fuels, which, if handled with any consideration, leave precious little time for such subjects as talc and limestone. What is the reason for this neglect of industrial minerals in geological curricula? It is certainly not due to lack of job opportunity for graduates, for there is a considerable and growing demand for geologists with training and interest in the industrial minerals. Possibly it is due partly to the lack of glamour and to the difficulty in dramatizing such subjects as gravel deposits, magnesite, and vermiculite. Surely one serious deterrent is the very diversity and technical complications involved in describing the 50-odd important industrial minerals. A student about to evaluate the field as a choice for a career, or as a subject of collateral interest, can be appalled at the mass of detail with which he is confronted and with which he must familiarize himself. For instance, a man can specialize for a lifetime in the clay industry and yet be an authority on only one phase of it. Another may become an expert in asbestos, and know something also about talc, and yet will be lost completely in the problems presented by fluorspar, sulfur, or the titanium industry.

*Geologist, Development Department, E.I. du Pont de Nemours & Co., Wilmington, Delaware.

Frustration may enter into the lack of general interest, since a geologist may find a rich deposit of high grade gypsum or a beautiful granite, but if the deposit is not near a railroad and close to a large market his discovery is worthless. Possibly an objectionable impurity just degrades it, like a little too much silica, or iron, or chromium, or something else that is all right in its place, but that is not the place! The geologist may find a big deposit of high purity wollastonite, like that at Willsboro, New York, but until research in technology finds applications and uses, the deposit may not be of any value at all.

The writer does not know how the subject is taught in the 48 colleges and universities. He knows how he tried to teach it a generation ago when he was still a college professor at the Massachusetts Institute of Technology. Although none of his students have followed the field, he himself found a commercial connection, as a result of his interest in the broad subject of industrial minerals, that has proven to be very stimulating and satisfactory. Hence, to its teacher at least, the course was a success. The writer maintains his broad interest in the whole field of industrial minerals by preparing an annual review for one of the national mining journals, that of the American Mining Congress. In that review he does not teach students, but he has to write in an interesting manner to attract the attention of readers who, unlike students in a class, do not have to read if they do not feel interested!

That annual experience of writing a general review and the long-past actual experience in teaching a course may qualify the writer to make these suggestions on how to plan and teach the subject of "Industrial Minerals."

I. The outstanding emphasis should be made on the importance of the field of industrial minerals to the economic life and the comfort and ease of the American people. The sand, gravel, and crushed stone industries are the largest segments of the industrial minerals field. The geological features of many of these deposits are interesting and important, but the student has been over most of that in his courses in glacial geology, sedimentation, and stratigraphy. He must know the specifications required of sand used in concrete and what are the Los Angeles Rattler tests on crushed stone and gravel, but those are details quickly picked up from standard references. Actually the aggregates industry is described in the greatness of America. It is seen in the sweeping miles of our express highways and turnpikes, in the beauty of the overpasses on the Merritt Parkway, in the majestic mass of the Shasta Dam, in the blue line of life-giving water in the All-American canal contrasted against the sands of the

Yuma desert, in the hundreds of acres of comfortable homes in Levittown, and in the convenience of the newest shopping center. Who said there is no glamour to sand and gravel? It drips with glamour!

Technical research in a thousand directions advances the use of industrial minerals: a new glaze makes a more attractive tile; addition of a little lime prevents the volume change in zirconia refractories which pass through an inversion temperature; variation in the composition of the metal oxides in the titanates changes the "K" factor of electrical capacity; the development of a new fluocarbon greatly increases the demand for acid grade fluorspar; a synthetic mica is made; jet engines require a refractory pad on which the planes may "warm up"; the bloating of clays has caused the development of a whole new industry. The field is alive with interesting technical developments to stir the inagination even of a sluggard.

II. Complex geological problems abound in the industrial mineral field and their solution can stimulate the most blasé. These may be entered into at length. The Coahuilian fluorspar deposits—are they epithermal or mesothermal? The size of the potential reserves is at stake in the interpretation. Are the titaniferous magnetites magmatic segregations, or pneumatolytic replacements? What is the origin of talc, of brucite, and of phosphate rock? The whole cycle of deposition of the evaporates commands the imaginative genius of the physical chemist as well as the geologist. Sulfur is a perfectly delightful problem and can arouse enthusiasm of every facet of interest from volcanology to economics. The mineralogy of the clays is a most fascinating subject, and when we geologists get into the problems posed to us by the ceramic engineers and designers we do have our hands full in meeting their rigid specifications.

III. Keep away from dry statistics and cataloguing of data. Thanks to two excellent reference books (AIMME 1949; Ladoo and Myers, 1951), each of which gives extensive bibliographies, and to the annual *Minerals Yearbook* of the U.S. Bureau of Mines and a library full of references, no student has to carry a mass of information in his head; but he should be trained to know where and how to look for such information.

Current information is flowing toward us through several general magazines like *Rock Products, Pit and Quarry, Journal of the American Ceramic Society, Engineering News Record, Brick and Clay Record, Mineral Trade Notes*, and the daily papers. In fact, the volume of current news of the industry is so large that one cannot keep up with it. A student should be made aware of it but not buried in it.

IV. If the geologist has had no training in mining, quarrying, and min-

eral beneficiation, he had better get some, either as a part of the course in industrial minerals or from courses in the mining department. A geologist may not be expected to run a mineral beneficiation plant, but he must know how such a plant works, and what can and what cannot be expected of one, and above all about how much mining and concentration cost. Without such knowledge a geologist cannot make an intelligent examination of a potential or actually operating property. Plant trips are worth a dozen lectures, and few schools are located at impossible distances from operating industrial mineral plants or quarries.

V. Perhaps just as important as production "know-how" is the need for understanding transportation problems and costs, freight rates, and alternative methods of shipping, such as barges and trucks. Should a geologist know how a bulk cargo is loaded or unloaded? If he was raised in Denver, he probably never saw a ship, but he can look at movies, or if the school is near a harbor the class can make a trip to it. No one will be bored.

In the vicinity of the school there may be a brick and tile manufacturing industry, a superphosphate plant, or even a paper mill using sulfur to make a sulfate or sulfite pulp, and using talc, kaolin, titanium oxide, or other fillers in the finished sheet. Get out and see one or more of these as part of the course. Observation is much better than listening to the drone of a professor's voice, hour after hour. In short, a course in industrial minerals must include plant trips and industrial trips, to see the production, beneficiation, handling, and use of some of these minerals.

VI. For advanced students a seminar may be held to which guest speakers may be invited if industrial mineral industries are available in the vicinity of the school. The student geological or mining club may also be a medium for inviting specialists to speak on industrial minerals.

In conclusion, the writer feels that a course in industrial minerals can be a bone-dry grind, boring to teacher and students, but if the spark of fire and enthusiasm is breathed into it, the subject will glow with the greatness of America and the intensity and diversity of American technology, and students will be shown vistas of a career that can be very stimulating and even remunerative.

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CLEAVAGE, A PHYSICAL PROPERTY FOR THE IDENTIFICATION OF MINERALS IN HAND SPECIMEN

Charles M. Riley
The University of Nebraska

ABSTRACT. A statistical study of all the recognized mineral species described in the most recent books on mineralogy has shown that nearly 66 per cent display cleavage of some kind. The variety of cleavage expression emphasizes the value of this physical property as a means of identifying minerals. The use of cleavage for the determination of crystal system is often possible when the student is guided by a simple set of rules. The tables in this report are a summation of the statistical study and include figures showing the distribution of cleavage according to crystal system and chemical composition. Other related information is also presented.

Cleavage is displayed by many minerals and is a physical property which is most useful for identification. It is one of the most constant properties and allows a subdivision into a great number of categories based upon (1) number of directions, (2) perfection, (3) angular relations, and (4) zonal distribution. For anhedral grains a study of the cleavage may, under favorable circumstances, lead to a determination of the crystal system. The significance of cleavage has long been known, yet it seems to the writer that insufficient emphasis has been placed on cleavage in the mineralogical literature read by beginning students in geology.

In order to evaluate fully the usefulness of this property, the writer attempted a statistical study of all the recognized mineral species whereby the variety of cleavage types could be determined, along with their relationships to crystal system and chemical composition. The study also makes it possible to answer such questions as: What percentage of minerals have no cleavage? Which crystal systems have the greatest number of cleavable minerals? Which chemical group of minerals has the highest percentage of species with cleavage?

PROCEDURE

The minerals considered in this study were those listed by Palache, Berman, and Frondel in Dana's *System of Mineralogy* . . . 7th edition, volumes I and II (1944, 1951). To these were added the silicate minerals described by Ford in Dana's *Textbook of Mineralogy*, 4th edition (1945). Only established mineral species were considered. Each cleavable mineral received a coded designation of the kind of cleavage it possesses and the crystal system into which it falls. Minerals with no cleavage were clas-

TABLE 1–TYPES OF CLEAVAGE RELATED TO CRYSTAL SYSTEM
(Expressed in terms of numbers of species represented)

Type of Cleavage	Isom.	Hexag	Tetrag.	Ortho.	Monocl.	Tricl.	Total	% of all cleav. minls.
1 direction								
a) Basal	–	78	19	32	65	3	344	37.2
b) Bladed	–	–	–	57	77	13		
2 directions								
a) Equal*								
1) 90° angles	–	–	8	–	–	–		
2) Not 90°	–	–	–	28	35	–	190	20.6
b) Unequal†								
1) 90° angles	–	–	–	46	31	1		
2) Not 90°	–	–	–	–	16	25		
3 directions								
a) Equal								
1) 90° angles	40	–	–	–	–	–		
2) Nor 90°	–	37	–	–	–	–	202	21.9
b) Unequal								
1) 2=;* 1≠	–	–	15	26	24	–		
2) All ≠	–	–	–	22	22	16		
4 directions								
a) Equal	24	–	6	–	–	–		
b) Unequal								
1) 3=; 1≠	–	24	–	–	–	–	116	12.6
2) 2=; 2=⊕	–	–	7	6	1	–		
3) 2=; 2≠	–	–	–	23	18	–		
4) all ≠	–	–	–	–	2	5		
5 directions								
a) Equal	–	–	–	–	–	–		
b) Unequal								
1) 4=; 1≠	–	–	3	–	–	–	21	2.2
2) 2=; 1≠	–	–	5	5	4	–		
3) 2=; 3≠	–	–	–	1	3	–		
6 directions								
a) Equal	10	–	–	–	–	–		
b) Unequal								
1) 4=; 2≠	–	–	2	1	–	–	23	2.5
2) 3=; 3=	–	9	–	–	–	–		
3) 2=; 4≠	–	–	–	–	1	–		
7 or more directions	9	5	11	2	1	–	28	3.0
TOTAL	83	153	76	249	300	63	924	100.0

* Equal (abbrev. =) means "of equal perfection."

†Unequal (abbrev. ≠) means "of unequal perfection."

⊕This means that there are two unequal degrees of perfection represented, each one equally developed in two directions.

TABLE 2–CLEAVAGE RELATED TO CRYSTAL SYSTEM: TOTALS AND PERCENTAGES

	Isom.	Hexag.	Tetrag.	Ortho.	Monocl.	Tricl.	Amor.	Cleavage* unknown	Totals
Total no. of species in each system	178	207	101	346	367	74	22	110	1405
% of all species in each system	12.7	14.7	7.2	24.6	26.1	5.3	1.6	7.8	100.0
Total no. of cleavable species in each system	83	153	76	249	300	63	–	–	924
Their % of each system's total no. of species	46.6	76.1	75.3	72.0	81.7	85.2	–	–	–
% of all cleavable species belonging to each system	9.0	16.6	8.2	26.9	32.5	6.8	–	–	100.0

*The crystal system is also unknown for most species in this column.

sified only as to crystal system or as amorphous. For many minerals, the information on some of the physical properties is either unknown, fragmentary, or doubtful. Where no information on cleavage was given, the writer used his judgment from the description to place the mineral in one of the following categories: "cleavage unknown" or "no cleavage." If cleavage or crystal system was only suggested in the descriptions, the information, even though doubtful, was accepted for the purpose of this study. The Dana system for chemically grouping the minerals was maintained throughout.

CLEAVAGE RELATED TO CRYSTAL SYSTEM

From the total of 1405 species considered, 924 (or nearly 66 per cent) have recognizable cleavage. Table 1 shows the distribution of these cleavable minerals according to crystal system and nature of the cleavage. Twenty-three categories were chosen, using number of directions of cleavage, equal or unequal perfection, and angular relationship. Many of these categories could have been further subdivided on the basis of zonal distribution. For example, of the 37 hexagonal species which have three directions of cleavage of equal perfection, about two thirds have rhombohedral cleavage, and the rest prismatic. However, for the sake of simplicity the factor of zonation has not been considered.

It can be seen by this tabulation that about 37.2 percent of all minerals that cleave do so in only one direction. A mineral with such cleavage could belong to any system but the isometric. For all other categories the cleavage is indicative of one or two, or in a few cases three, crystal systems. Even then, a further consideration of angular relationships (not used

TABLE 3–CLEAVAGE RELATED TO CRYSTAL SYSTEM AND CHEMICAL COMPOSITION: NUMBER OF SPECIES (For each composition, upper row of figures gives number of species with cleavage, middle row gives number without, and third row gives number for which data on cleavage, and usually on crystal system also, are unknown.)

Chemical Composition	Isom.	Hexag.	Tetrag.	Ortho.	Monocl.	Tricl.	Amor.	Cleavage unknown	Total
	5	12	1	2	1	0	–		21
Elements	12	2	1	0	0	0	0		15
								2	2
	31	15	2	15	5	0	–		68
Sulphides	11	4	2	5	3	0	0		25
								11	11
	3	5	0	19	19	2	–		48
Sulfosalts	7	1	0	6	6	0	0		20
								14	14
Oxides	13	19	13	27	9	2	–		83
	19	6	7	10	3	0	7		52
Hydroxides								9	9
	12	14	11	10	5	0	–		52
Haloids	4	3	2	6	1	0	1		17
								4	4
	0	16	2	14	15	0	–		47
Carbonates	3	3	1	3	3	1	0		14
								5	5
	14	23	17	61	114	22	–		251
Silicates	27	14	7	37	22	0	10		117
								15	15
Phosphates	1	27	15	53	62	18	–		176
Arsenates	3	9	1	15	9	4	4		45
Vanadates								16	16
Nitrates									
Iodates	1	3	3	11	19	4	–		41
Borates	2	2	2	4	2	2	0		14
Uranates								4	4
Sulphates									
Chromates	1	16	1	26	41	13	–		98
Tellurates	6	9	1	9	16	4	0		45
Tellurites								19	19
Selenates									
Van oxysalts									
Molybdates	2	3	11	11	10	2	–		39
Tungstates	1	1	1	2	2	0	0		7
Antimonates								11	11
Antimonites									
TOTALS	83	153	76	249	300	63	–		924
	95	54	25	97	67	11	22		371
								110	110
GRAND TOTALS	178	207	101	346	367	74	22	110	1405

TABLE 4–CLEAVAGE RELATED TO CHEMICAL COMPOSITION: PERCENTAGES

Chemical Composition	% of known minerals of this comp.	Percentage of each composition			% of all cleavable minerals having each composition	% of all non-cleavable minerals having each composition
		With cl.	Without cl.	Unknown		
Elements	2.7	55.2	39.5	5.3	2.3	4.0
Sulphides	7.4	65.4	24.0	10.6	7.4	6.7
Sulfosalts	5.8	58.5	24.4	17.1	5.1	5.4
Oxides Hydroxides	10.2	57.7	36.1	6.2	9.0	14.0
Haloids	5.2	71.2	23.3	5.5	5.6	4.6
Carbonates	4.7	71.2	21.2	7.6	5.1	3.8
Silicates	27.3	65.5	30.6	3.9	27.2	31.6
Phosphates Arsenates Vanadates	16.9	74.3	19.0	6.7	19.1	12.1
Nitrates Iodates Borates Uranates	4.2	69.5	23.7	6.8	4.4	3.8
Sulphates Chromates Tellurates Tellurites Selenates	11.5	60.5	27.8	11.7	10.6	12.1
Van. oxysalts Molybdates Tungstates Antimonites Antimonates	4.1	68.4	12.3	19.3	4.2	1.9

in the table where more than three directions are present) often makes possible the exact determination of the crystal system. Suppose a certain mineral has three directions of cleavage, all of unequal perfection. With this much information one could say that the mineral is either orthorhombic, monoclinic, or triclinic. However, if it were also determined that the three directions make right angles with each other, one could say with certainty that the mineral is orthorhombic.

Since cleavage is always parallel to crystal faces or possible crystal faces, it can be thought of in terms of crystal forms. With a suitable back-

ground of crystallography the student may utilize cleavage for the determination of crystal systems if he is guided by the following simple rules, using the crystallographic terminology adopted by Hurlbut (1932): One direction of cleavage is always parallel to what would be a pinacoid. Two equal cleavages (i.e., of equal perfection) indicate the presence of a possible prism. Three equal cleavages correspond to either a cube, a rhombohedron, or a hexagonal prism, depending upon the angular relationship.[1] Four equal cleavages indicate either an octahedron or a tetragonal or orthorhombic dipyramid.[2] When one considers which crystal systems contain the above-mentioned forms existing alone or in combination, it is a simple matter to use the cleavage to determine crystal system. The above statements may seem axiomatic to most readers, but the writer feels that their importance to the beginning student in mineralogy cannot be over-emphasized. The student learns that interrelationships exist between the different physical properties, and that this is to be expected where such properties are all manifestations of the same ordered arrangement of ions and atoms in the space lattice.

CLEAVAGE RELATED TO CHEMICAL COMPOSITION

Table 3 is a treatment of all the minerals, including the cleavable, noncleavable, and species of "unknown" cleavage, relating cleavability to chemical composition and crystallography. These data answer the questions stated in the introduction, and many others concerning the proportion of minerals which are classified in the various chemical groups or in the different crystal systems. They point to no grand conclusion but only emphasize how unrelated are the physical properties to the chemical composition. Minerals with similar structures have similar physical properties, and it is commonly true that a phosphate and a silicate have structures more similar than those of two silicate minerals. An attempt to make a correlation between cleavage and chemical composition was equally unfruitful and for the same reason. Except for several isostructural groups of minerals, there was a remarkably even distribution of all the members of any chemical group throughout the many categories of cleavage.

[1] A trigonal pyramid and a dipyramid are also possible, but no examples of these were found.
[2] This is very rare.

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GEOLOGY AS A CORRESPONDENCE COURSE

H. A. Ireland
University of Kansas

ABSTRACT. The author developed a correspondence course in general geology which has been used at the University of Kansas for the past six years. Students have been highly enthusiastic about the course, some taking it for credit, others for personal or cultural reasons. Students range in age from college students to those past 60 years. A large part of the success of the course is attributed to the use of mineral, rock, and fossil specimens and geologic and topographic maps. Students are required to purchase the topographic maps, but the other materials are mailed to them on loan. In addition the students are required to collect and identify specimens from their own localities. This eliminates the objection of lack of laboratory work and contact with earth materials which most geologists give as a reason for not offering such a course. An outline of the course and carefully worked out laboratory exercises direct the student in his studies of the specimens and maps, and a series of written exercises and quizzes on them and the text material must be sent in for correction. The procedure is described in the hope that similar courses may be undertaken elsewhere, bringing to many who would otherwise be denied it the pleasure of a general cultural knowledge of geology.

When I was approached by the Director of the Bureau of Correspondence Study at the University of Kansas and asked to prepare a new course in geology I was opposed to the idea and skeptical of the results. A geology course, to be effective, should have field work and laboratory exercises, for a true knowledge of rock origin, relation, geologic expression, and distribution cannot be secured otherwise. There must be an opportunity to handle and examine rocks, minerals, and fossils and to observe their relations in place. Since I had taught 42 semester courses in elementary geology over a period of 25 years I had certain ideas which were not amiable to the offering of a course by correspondence. However, the perseverance of the Director, certain other arguments, and a rearrangement of my ideas led me to attempt the composition of the course. I entered into the task with the idea of producing the best course possible and of introducing rock and mineral specimens, maps, and field work in some feasible manner.

The results during the past five years have been extremely gratifying. Several persons who have completed the course have called to see me and express their enjoyment of the work. One young lady took time on her honeymoon to write me how the course increased her enjoyment of travel in Colorado—and how her knowledge impressed her husband. A doctor who had a Boy Scout troop came to see me one Sunday afternoon and apologized for disturbing me, but he wanted to be certain of the pronunciation

of certain technical terms. He brought along a tape recorder and a list of 250–300 words for me to put on the record. The novelty of the situation amused me, and the ingenuity impressed me. The effort and interest of the doctor indicate that the course has been desirable and useful to others than those wanting college credit. An oil well driller wanted the course to improve his business; a young wife wanted to learn more about geology because her husband was a geologist; other persons have wanted it as a preparation for travel, to satisfy curiosity, or for specific reasons not known. Many of those who take the course are students seeking university credit.

Several oil companies made inquiries through the *Geological Newsletter* of the American Geological Institute concerning which universities offered correspondence courses in geology. I wrote the editor of the *Newsletter* and found that one of the oil-company men was well known to me. I later talked with him and found that his company wanted to pay the fees and furnish correspondence courses to non-geological employees, including those in foreign countries.

Another doctor, prominent in Kansas City, took the course for cultural reasons and wrote the following letter. Later, he visited me.

My Red Pencil:

With this last assignment I have completed the course in Geology, except for the examination for credit. As I am not interested in credit for the course, I will not be interested in the final examination.

I want to thank my "Red Pencil" for patience with a bad scribe. If it were not for your knowledge of geology and familiarity with the questions, and what was expected, I doubt whether you could decipher my writing. My only consolation is in the fact that with few exceptions M.D.'s are very poor penmen.

I also want to express my great appreciation of the course and the way it is conducted. I have enjoyed every minute of the time I put in, and I must say that it did stimulate a great deal of outside reading.

I want you to know that I recommend the course to anyone interested in travel, and what one sees as we pass over a countryside, whether it be mountains, plains, lake country, or seashore. I have told many of my friends and given the course an enthusiastic sendoff.

While this letter contains statements that are personally gratifying, I quote it only to illustrate the appreciation which the course engenders.

Miss Ruth Kenney, Director of the Bureau of Correspondence Study at the University of Kansas, has the following to say about the course:

The course in geology offered by correspondence through the University is a carefully prepared and thoroughly satisfactory course. One student who had begun the regular lecture course in residence was allowed by his dean to complete

the course by correspondence during a sojourn in the student hospital. (He was there for several months.) His report was: "This course is wonderful, and I feel that I am lucky to be able to finish it by correspondence study." This student's work was excellent and he was able to write a superlative examination.

While this course requires a lot of extra work and time in sending out minerals, rocks, maps, fossils, and the geological atlas, we feel that it is one of the finest courses we have and recommend it to students, teachers, workers in the oil and gas fields, and others.

Miss Kenney wrote the following in response to the letter from the doctor quoted above:

We think that geology is a splendid course and all the students who have taken it have liked it. Some have felt that it is an awful lot of work, but even then they have liked it. Most of the students who have taken the work have taken it for credit to count toward a degree, so they had an additional incentive to study. The fact that you took it because you were interested is much more important, and your opinion would be rated higher than that of students.

I cite the examples in the above paragraphs to illustrate the diversity of interest in the course and to demonstrate its service in bringing geology to those unable to get it otherwise.

The collection of rock, mineral, and fossil specimens, with lapidary work and silversmithing included in many cases, has become a widespread hobby. There are a dozen or more clubs in Kansas with a membership of 40–100 in each, and there are hundreds of clubs throughout the United States. I belong to a local one organized two years ago. It has over 40 members, of whom only three are professional geologists, and I am the only one from the University faculty. Because I submerge my professional standing and take an interest in the lapidary work, I am in good standing as a fellow rock hound. Professionally, I am amazed at the knowledge, enthusiasm, energy, time, and money put into the club and its field trips, trading, and individual enterprises. The club stages an outstanding annual show and display that has attracted wide attention over the state. Its novelty and success have been so great that the City Recreation Commission is furnishing space for meetings and has purchased lapidary equipment. I mention these clubs somewhat as an aside from a discussion of correspondence courses, but they are related, because these persons are potential users of such courses and they include a large number of people throughout the nation. I cannot stress too much the desirability of encouraging and helping these people to acquire knowledge of their natural environment and an appreciation of and interest in geological phenomena. In many cases a correspondence course is their only opportunity to secure an organized treatment of geology.

Table 1—Outline of Correspondence Course in General Geology at the University of Kansas

Preliminary statement, general instructions, and bibliography

Section I

1. Introduction. Geologic time scale
2. Materials of the earth: elements and minerals
3. Quiz No. 1. Mineral identification
4-6. Materials of the earth:
   Igneous rocks (4)
   Sedimentary rocks (5)
   Metamorphic rocks (6)
7. Quiz No. 2. Mineral and rock identification

Section II

8. Introduction to topographic maps
9. Quiz No. 3. Topographic maps
10. Vulcanism
11. Topographic maps showing vulcanism
12. Earthquakes and conditions within the earth
13. Diastrophism
14. Topographic maps on diastrophism and geologic structures
15. Areal geologic maps and structural sections
16. Origin and structure of mountains
17. Quiz No. 4. Subject matter of assignments 10-16

Section III

18. Atmosphere and weathering
19. Wind as an agent of gradation and topographic maps on wind work
20. Ground water and mass movement
21. Topographic maps on ground water
22. Quiz No. 5. Subject matter of assignments 18-21
23. Gradational work of streams: stream erosion
24. Topographic maps showing erosion by running water
25. Topographic maps showing special forms due to erosion
26. Gradational work by streams: deposition
27. Topographic maps showing stream deposition
28. Quiz No. 6. Subject matter of assignments 23-27

Section IV

29. Gradation by snow and ice
30. Topographic maps showing alpine glaciation
31. Topographic maps showing continental glaciation
32. Quiz No. 7. Glaciation
33. Oceans and shorelines
34. Topographic maps of shorelines
35. Lakes and swamps
36. Topographic maps showing lakes
37. Fossils
38. Mineral deposits
39. Oil and gas
40. Quiz No. 8. Subject matter of assignments 33-39

Final examination

There are very few correspondence courses in geology offered in the United States. I know of only three other institutions outside of Kansas that have them. This lack is probably due to the viewpoint of many geolo-

gists that laboratory and field work are essential and are not feasible by correspondence. Also, there are men who are prejudiced against the idea, just as I was until I made the effort to compose a course and found that the results justified the effort.

The course at the University of Kansas is a 5-hour course having 40 units as assignments. These include units concerning rocks and minerals, geologic forces and structure, gradational processes, principles of topographic and geologic maps, fossils, and applied geology. The textbook work and instructional parts are interspersed with exercises and maps concerning the geological subjects, and eight of the assignments are quizzes. The textbook is the same as that used in the University's lecture class, and the exercises, explanations, and illustrations were lifted or modified from my laboratory manual prior to its publication in 1951. The laboratory manual material was composed to be essentially self-sufficient, so that if the explanations, instructions, and procedures are read and carefully followed, the principles and facts to be learned can be understood. The success of the pilot laboratory manual during several years of use and revision was an indication that the parts used in the correspondence course provide adequate instruction without the presence of an instructor. The subject matter for each textbook assignment is outlined, indicating the special points to be studied. Questions are included at the end of each assignment, and each student mails in the answers to them, which develops a mental formulation of the contents of the assignment.

The list in Table 1 includes the subject headings for each of the 40 assignments for the course in geology at the University of Kansas.

The first seven assignments cover introductory material and a treatment of earth materials. The introduction contains a survey of the fields and uses of geology and a discussion of the geologic time scale. A small amount of chemistry is given to explain the role of elements and compounds in rock and mineral composition and in the chemical processes of erosion and deposition. Several sets of 25 minerals, each specimen about 1-2 cubic inches in size, are on file at the correspondence office, and a set is mailed on loan to each student for study in connection with tables and descriptive matter in the course material and in the textbook. Questions placed at the end of each assignment must be answered and mailed in for grading along with the return of the mineral set. When the assignment is completed and the mineral set returned, a second set of 50 minerals is sent out as a quiz. Many duplicate minerals of different general appearance are included to test the student's knowledge of mineral properties and identifications. Assignments on igneous, sedimentary, and meta-

morphic rocks, with tables and text, are followed by a quiz, in the same manner as for minerals. One part of the three assignments on rocks is to go to outcrops and collect, identify, and mail in, for checking, several types of rocks. This completes Section I of the course.

Assignment 8, on topographic maps, takes up scale, latitude and longitude, land subdivisions, drainage, culture, and relief. The principles of contour lines are explained, and exercises are given for practice in the use of contours to express the third dimension on a map and for drawing topographic profiles. Answers to questions consolidate the instruction and complete the assignment. For use in the assignment and for later map work, students purchase 38 selected topographic quadrangles of various parts of the United States published by the U. S. Geological Survey. The maps are stocked by the University and sold to students at cost ($5.85), passing on to them the discount allowed by quantity purchase. Each map was selected because it illustrates some process or feature concerned with geology. Care was taken to select maps that include many national parks and other areas where a person might travel or go on a vacation. Thus most of the maps can be used after the completion of their specific use with the course. In many cases a single quadrangle illustrates several features and is used in several different exercises. Assignment 9 is a quiz on topographic maps and profiles.

Assignments 10-17 include the study of the forces of vulcanism and diastrophism. Each subject has textbook reading, an outline, and a series of questions to be answered and mailed in for grading. Writing answers to the questions, even though the textbook is used, is a good pedagogical method to consolidate the reading matter in the mind of the student. Map exercises are included to teach the distribution and occurrence of these two forces. Structural maps and geologic cross-sections are introduced, and a large number of diagrams, illustrations, and explanations are used in the assignment sheets. Colored geologic maps for stratigraphic and structural principles are contained in two folios of the Geologic Atlas of the United States, mailed as a loan for study. A quiz on these items completes Section II of the course.

Assignments 18-29 comprise Section III and treat the processes of gradation by wind, ground water, and running water. Each subject has textbook reading, an outline, and questions, which are followed by map exercises on the topographic expression of each agent of gradation. A quiz on wind and ground water and a second one on running water are included in the section (see Table 1).

Assignments 29-40 in Section IV of the course deal with glaciation,

oceans and shorelines, lakes, fossils, mineral deposits, and petroleum. One reason for the inclusion of the last three topics is to satisfy curiosity about some of the chief arousers of interest in geology–the glamour, uniqueness, and antiquity of fossils; the ever-present use and demand for mineral products; and the widespread association of geology with the production of petroleum. Several sets of about a dozen common invertebrate fossils are maintained as loans for study, to acquaint the student with some of the ordinary fossils that may be found in sedimentary rocks.

The final examination is written without assistance at a "Supervised Examination Center." The centers designated are: the dean's office of the college where the credit is to be accepted; in the correspondence study office of any of the five state colleges; or one of 23 listed high schools, colleges, or extension centers of the University, which are well distributed throughout the state. Non-residents of Kansas are given specific instructions, and special arrangements are made for their examinations. All other quizzes are honor quizzes, presumably taken without aid from notes, exercises, or other persons.

Fees for the course are the standard charge of $6.00 per credit hour for residents of Kansas and $9.00 per credit hour for non-residents. This includes the mailing costs from the University, but the student pays the return postage. Rock and mineral specimens are restricted to a minimum size in keeping with the necessity for showing their characteristics adequately, and thus the postage costs are not excessive. All grading is done by me or by a selected properly qualified assistant.

The great interest shown by those who have taken the course and its apparent success have caused me to reverse my ideas concerning the adaptability of a general course in geology to the restrictions of correspondence procedures. The integration of the subject matter with rock and mineral specimens, fossils, and maps has been the principal factor in making the course meet the standards I consider necessary for an elementary knowledge of general geology. The provision of sets of rocks, minerals, and fossils for loan and the willingness to take the time for and meet the expense of packaging and mailing these items offset the objection to giving a geology course without supervised laboratory work. The selection of interesting maps, acquired at low cost for use in the course and after its completion, is another factor which has contributed to the success of the course.

The correspondence course in geology is limited to a general course. Advanced work requires instruction by well-trained experienced men and the provision of laboratory specimens, maps, apparatus, and equipment

impossible to mail. Work in advanced subjects also requires much field work under adequate instruction, which is not possible by correspondence. A course in historical geology appears feasible to me, but it has not been developed here.

It appears unreasonable and illogical to me that a large number of persons who wish only a cultural and general knowledge of geology should be denied it for the reason that supervised laboratory work and direct contact with specimens are not feasible. My experience indicates that laboratory exercises with specimens and maps *are* feasible if properly organized. To those who reject the idea of offering geology by correspondence I say– if the results obtained from a study of geology by correspondence are not as full as results by lecture and supervised laboratories, at least there are many more happy and geologically informed persons in the world than there would have been without a correspondence course.

As teachers, our job is education and the dissemination of knowledge. It is my desire to pass on to other teachers of geology my experience in what appears to be a successful method of adequately presenting a correspondence course in geology. I recommend that others who see the need and have the opportunity and the facilities develop a similar course for use within the areas served by their colleges or universities.

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FIELD TRIPS AS AN INTEGRAL PART OF HISTORICAL GEOLOGY*

Grant T. Wickwire
Hanover College

ABSTRACT. In the author's classes in historical geology, approximately six weeks of laboratory study is devoted to fossils before going into the field. Following this study field trips are made, first to exposures of the oldest formations followed by trips to successively younger horizons. Both rocks and fossils are collected and subsequently studied in the laboratory.

The field trips arouse interest, show the student direct evidence of faunal change from age to age, and give some insight into lithologic changes that may accompany some faunal changes. Most important, by means of field work the beginning student starts to work "on his own" instead of depending entirely on what has been written by others.

Geologists generally agree that field trips are not only desirable but necessary in any course in geology. Indeed, the words of Severinus, "If you would know nature sell your books and buy stout shoes," written nearly four centuries ago, apply with even more force today, for there are now so many books in which erroneous preconceptions may be perpetuated.

That field trips in historical geology can be undertaken with equal advantage in every locality is not to be expected. The regions covered with glacial drift or underlain with igneous rocks are poor hunting grounds for the embryo historical geologist. Therefore, what I have to say here applies only to regions suited to historical study, and particularly to Jefferson County, Indiana. Here, within a radius of ten miles, rocks and fossils ranging in age from upper Maysville (Ordovician) to lower New Albany (Devonian) occur in a series of excellent exposures.

After some preparation in the laboratory and classroom, students can be taken into this area with great advantage.

PREPARATION FOR FIELD WORK

Laboratory work for approximately six weeks is devoted to studying what fossils are, how they occur, and what to look for in identifying genera and species.

With this objective in mind, the geology department at Hanover College has developed and maintains a museum which displays a nearly complete collection of local fossils arranged stratigraphically. The first lab-

*Presented on March 30, 1951, at the eleventh annual meeting of the Association of Geology Teachers, at DePauw University, Greencastle, Indiana.

oratory hours are spent in this museum. Laboratory directions are phrased so as to lead the student toward an overall picture of the fossils of the vicinity. At the same time he sees that faunas do change from age to age. Finally, the student's interest is aroused—sometimes.

The museum is a relatively new feature. It is expensive. Housing alone costs a great deal, construction costs being what they are today. Cases for the display of collections are also costly, and the preparation of display material requires highly skilled labor.

Before this department had a museum, a fairly satisfactory substitute was developed and is still used to a limited extent. A series of glass-covered trays display properly labeled specimens. These trays fit the "piling cabinets" made by the Interior Steel Company of Cleveland. Each tray is 21 by 27 inches and either 1 5/8 or 3 5/8 inches deep, depending on the thickness of the largest specimen used. Trays can be made locally, and the glass covers are held by metal strips across the corners. A tray and glass unit completely assembled but without mounted and labeled specimens costs about $4.50. As preparation for field work such trays are nearly as useful as the far more costly display cases. (For a description of the construction of such trays, see pp. 30-32.)

Before going into the field the beginning student must learn what constitutes an identifiable fossil. In a region where fossils are abundant there is always a far greater quantity of fragmental material than of usable specimens, as every fossil hunter knows. Unless considerable stress is laid on gathering specimens in which critical features needed for identification are preserved, the average student will gather quantities of scrap, preferably well-rounded water-worn scrap. Why such stuff appeals to a student is a mystery.

Reading material describing formations and the geology that the student is to meet in the field is another feature of laboratory preparation for outdoor work. Pamphlets prepared by the departmental staff give summary descriptions of the local geology. Original reports published in journals and bulletins of the state and national surveys are also provided. These materials, especially the summary pamphlets, are used by the student without urging.

Partly for the convenience of the instructor, but primarily to impress on the student the importance of accurate and systematic collecting by horizon, mimeographed sheets are issued listing the formations of each period. These sheets (Fig. 1) have a space for inserting the name of the fossil, and also a column in which to list the source from which the identification was obtained.

ORGANIZATION OF FIELD TRIPS

Since excellent collecting areas are within easy walking distance of the campus, a considerable part of the field work is done on foot. For the longer trips both private cars and chartered buses have been used. For a variety of reasons, the matter of accident liability being one, the chartered bus is preferred, with the cost being paid from the laboratory fees.

The trips are planned as a series, and the field study is begun with the oldest formations exposed. For successive trips the students visit

HANOVER COLLEGE
FOSSIL COLLECTION

No. SILURIAN SYSTEM Name _____

Genus and Species	Geological Horizon					Locality	Identif. source
	Br	O	La	W	Lo		

Fig. 1— Heading of sheet used for reporting fossils collected. A key to symbols used is provided. In the sample shown here the formations represented are: Br—Brassfield; O—Osgood; La—Laurel; W—Waldron; Lo—Louisville.

progressively younger formations, and some care is taken to make each trip overlap its predecessor, stratigraphically speaking. Thus each trip furnishes a partial review of the previous one. There is another reason for this overlapping. The last one or two stops are made at the end of the day when the student is tired and less attentive. To revisit them when he is fresh is always profitable, and especially so with beginning students.

Because interest lags after a few hours of work in the field, short trips are to be preferred to longer ones. The usual two-hour afternoon laboratory period seems to be about the beginner's limit for sustained attention. To be sure, where distance to the collecting ground requires more than 20 minutes of driving each way the period has to be longer, but the actual time spent in the study of rocks and in collecting fossils is not planned to be over two hours.

In addition to the supervised trips students are encouraged to do field collecting independently. All the better students do a great deal of individual work in the field. Hammers are loaned by the department, and every student has one that he keeps during the weeks when the weather permits outside work. As an added incentive to individual work, students can get

permission to be absent from regular laboratory meetings to do independent work in the field. In the main the privilege is not abused.

TEACHING ADVANTAGES OF FIELD TRIPS

For the beginning student the field trip adds interest. After the first trip or two there is the anticipation of finding a specimen more perfect, more rare, or in some respect superior to that of any other student. This friendly competition adds zest to the field work. Indeed, the student who fails to find a real satisfaction in discovering a clean, well-preserved specimen is rare.

And for interest rousers there are trilobites! Every beginning student searches madly for a trilobite. Fair specimens of just a few species occur in the local rocks, but they are not especially important as horizon markers. There seems to be no logical reason for this all-but-overwhelming interest in trilobites, but it is present and it is a help. The "thrill of the hunt" is present in fossil collecting, and this fun compensates in some measure for the exacting and hard work of naming the "catch."

This matter of naming the "catch" is done in the laboratory and museum, preferably in the laboratory period immediately following the field excursion, and is an integral part of the whole field experience. The museum displays complete faunas of all the formations visited in the field, and thus the student is able to name his "catch" simply by comparing it with a displayed specimen. Descriptive literature on the fossils likely to be found is also available in the laboratory.

Field trips made in the company of an instructor make this method of identification by comparison rather easy. The particular area being studied is identified by the leader as the "Waldron formation of the Silurian," or whatever it may be. The alert student makes a note of this fact, and so his search in the museum is limited to fossils of that particular formation.

In independent work this advantage is lacking, and from the evidence of his collection the student must name the formation from which he did the collecting. It is to forward this training that independent work is urged.

Although work in the museum has stressed the point, only field work drives home the realization that faunas do change, and change suddenly. Thus formations become real. Factual evidence for separating one bed from another immediately above or below it is before the eyes of the student. In this way the successive steps in geologic history become more than mere words in a text.

The value and the limitations of molds, casts, and imperfect or distorted specimens are learned early by actually working with the material.

Whether or not to attempt identification of a specimen requires the exercise of some judgment, which is gained only by experience.

In some instances lithologic changes accompany faunal changes. When they accompany a faunal change, changes in color, texture, or composition of the rocks make the demarkation of a formation seem natural and simple. When lithologic changes are absent, the importance of fossils is more clearly appreciated.

The names of things actually handled in the field tend to stay in the student's mind. All of us know that an object, whether it be fossil, or rock, or formation, demands a name. Otherwise how can we talk about it? Thus, almost without conscious volition, the student finds himself using and remembering names of formations and terms descriptive of lithology. Since vocabulary is a necessary part of any elementary science study, this ease of learning and remembering is significant.

Only when the student has been in the field can he begin to understand that the textbook describes the ideal, and that the ideal is seldom found. This is not criticizing our texts. The ideal condition should be used for the sake of clarity, but the sooner the embryo geologist recognizes it as the ideal and not the expected, the better.

Too frequently students have a strange and varied assortment of misconceptions, geologic and otherwise. Seemingly an instructor can tell the student time and time again that his misconceptions are not valid. The student fails to hear or refuses to listen. But take that student into the field and make him test his faulty notion. When it fails to work he will abandon it, and such testing seems to be the only thing that will force him to abandon long established misconceptions—short, that is, of death itself!

Finally, where else can training in observation be so pleasantly yet thoroughly acquired? That accurate observation is the foundation of all sound work is axiomatic. Practice in the field is certainly the best way to acquire this ability.

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A CONVENIENT DISPLAY TRAY

Grant T. Wickwire
Hanover College

ABSTRACT. This article describes the construction and use of a display tray that can be built inexpensively and used for student study of geologic material in lieu of more costly museum exhibition cases.

In another article in this journal (pp. 25-29) the advantages of glass-covered trays in which rocks, fossils, and minerals are displayed for student use are discussed. A description of the making of these trays follows, at the risk of sounding like a "how-to-do-it" article for the home handy man.

CONSTRUCTION

A standard 4' x 8' x ¼" plywood sheet is cut into two 4' x 8' x ¼" pieces. These can then be cut into four pieces, each 21" x 27". This 21" x 27" panel is the foundation of the display tray, on which sides are erected.

Experience at Hanover has shown that sides 1⅜" or 3⅜" high satisfy most requirements. The accompanying illustration (Fig. 1) shows the details of assembly.

White pine lumber ⅜" x 1⅜" is best for the sides and back of the tray. The front, which takes the strain of withdrawal from the storage cabinet, is made of 25/32" (1" dressed) x 1⅜" stock.

This front is cut 20" long, and at each end it is notched (rabbeted) ⅜" x ⅜" to take the side pieces. A one-inch hole is drilled in the center of the front for a finger grip when withdrawing the tray from its storage cabinet.

Sides are 26⅝" long, mitered at the back and fitting the rabbet at the front. The back is mitered to fit the sides.

It will be noted that the outside dimension of the front is one inch less than the plywood base, thus leaving a half inch on each side designed to fit the supports in the storage (piling) cabinet.

Assembly of the tray needs some care. Edges of the front, sides, and back are glued *and* nailed to the base. Both are necessary in order to reinforce the plywood. Experience has shown that when either has been im-

perfectly done even a moderate weight of specimens makes the plywood bottom sag.

MOUNTING STUDY MATERIAL

Whenever it is possible, shallow trays are used so that specimens can be mounted close to or even lightly touching the underside of the glass cover. This permits examination with a hand lens if necessary.

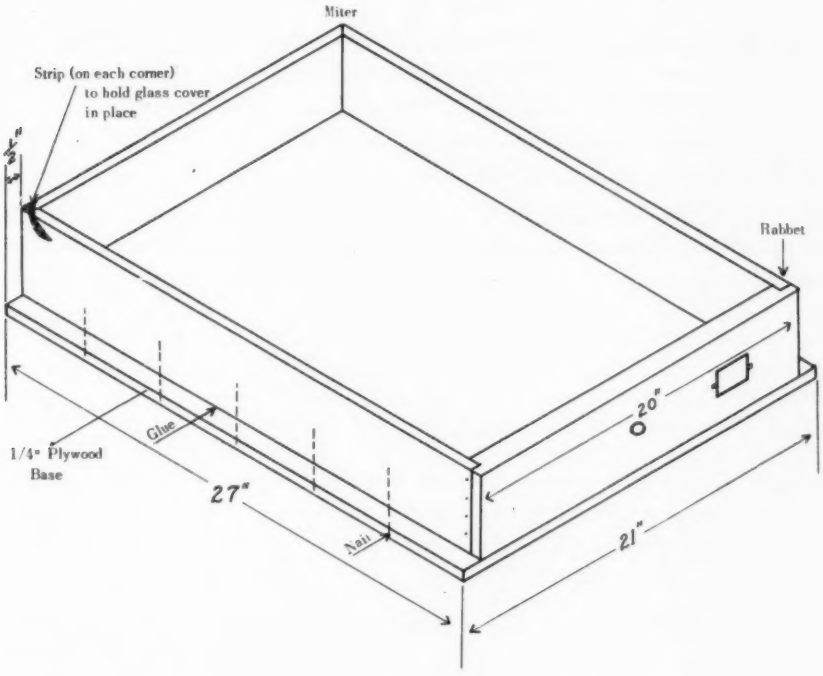

Fig. 1—Construction diagram showing details of assemblying display tray.

Each specimen is placed in a 3" x 4" cardboard tray with a block below the specimen to carry a label.[1] For the cover, double-strength window glass, 20" x 27", is used. Aluminum strips, crossing each corner and secured to the wood, hold the glass in place.

STORAGE

When not in use these trays are stored in "piling cabinets" made by Interior Steel Equipment Co., Cleveland 4, Ohio but not carried in stock by them.

1 Ward's Natural Science Establishment sells a tray similar to the above, with a built-in cardboard surface for the label.

This piling cabinet is the only expensive item required, but it is worth the cost. It is virtually dust-proof because of careful construction. Furthermore, the tray supports in the cabinet are so made that storage is extremely flexible, with little wasted space between trays.

The cabinets will carry heavy loads and can be stacked one on another if space is limited.

USE OF TRAY DISPLAY

Students at Hanover are required to collect rocks in the physical geology course and fossils in the historical course. These courses comprise a year of work and are the students' introduction to the subject.

At this early stage of their geologic education, descriptions of either rocks or fossils as found in the literature are beyond the ability of most of them to follow successfully. Comparison with a well-displayed specimen is not difficult, yet it offers excellent discipline in accurate, detailed observation.

BOOK REVIEWS

Historical Geology Laboratory Manual. James Brice. v and 167 pp. Wm. C. Brown Co., Dubuque, Iowa, 1954. $2.90 .

Every new laboratory manual that is published for a course like Historical Geology immediately raises the question as to what type of institution will find it useful. In some cases a manual is so provincial, including a lot of local geology and local field trips, that its use, outside of a rather restricted area, is not feasible. Other manuals are too limited in their coverage, reflecting the character of the course as taught at a particular college. This new manual by Brice avoids these difficulties. It should prove to be useful in both small colleges and large universities, in places where the professor who is giving the lectures handles the laboratory and also in places where the laboratories are taught by graduate assistants.

According to the author, this manual is not planned to parallel the lectures in the course, but rather to teach those aspects of Historical Geology that cannot be taught in the classroom. It is to act as a complement rather than a supplement to the text and lectures.

The variety of subjects covered is so great that it is possible to arrange the semester's work to suit almost any course that could be taught. This is particularly important when one considers the great diversity in the courses that are given in different colleges. For example, much of the paleontologic material might well be skipped in a school where Paleontology is taught as a separate course. The same can be said for the exercises that deal with the stratigraphic range of the various fossils, for colleges where courses in Stratigraphy and Index Fossils are taken by all majors. On the other hand, there are many schools where these advanced subjects are not taught, and if the student is not introduced to them in Historical Geology he will never know anything about them. It is therefore very wise to have such a wide field of material to choose from in setting up one's laboratory schedule for the course.

After a brief discussion regarding the nature and origin of fossils there is a very adequate discussion of the various animal and plant groups, well illustrated by both photographs and line drawings. The next section deals with the use of fossils as Index Fossils and is accompanied by an exercise having line drawings for identification, both as to genus and geologic range. The next fifty-odd pages are devoted to the interpretation of the sedimentary rocks, the problems of lithofacies and biofacies, unconformities and structural problems that might be found in the field, with plenty of exercises to be done by the student. A discussion and exercises on the construction and reading of geologic maps follows. The final subject is a consideration of the Physiographic Provinces of the United States, with problems which bring out the geologic history of the various provinces.

The manual is well organized and well illustrated, and the reproduction is almost uniformly good. There are a few places where the change in scale has made it difficult to read the labelling on some illustrations taken from other authors. Due to the spiral type of binding, the manual when open lies flat on the table, and the student will not have to be continually looking for the page that he was

working on, as happens with some other types of binding which do not lie flat. From the student point of view this is an added advantage.

LAWRENCE WHITCOMB

Lehigh University

Petrography, an Introduction to the Study of Rocks in Thin Sections. Howel Williams, Francis J. Turner, and Charles M. Gilbert. x and 406 pp. W.H. Freeman and Co., San Francisco, 1954. $6.50

During the last few years a number of excellent petrology textbooks have found their way onto the market. However, the descriptive study of rocks—the science of petrography—has not seen a comparable upswing. For a study of rocks in thin section one has had to rely on British textbooks, such as Tyrrell's *Principles of Petrology* (now out of print) and *The Petrology of the Igneous Rocks* by Hatch and Wells. There has been a long-felt need for a textbook on petrography that is readily available and that illustrates North American rock occurrences rather than the "classic" European localities.

The book being reviewed is intended for students who have already mastered the art of hand-specimen rock identification and who are acquainted with the principles of optical mineralogy. The authors state that with this background "the present subject matter may be covered adequately by a year's course of six hours' laboratory work a week; indeed, by a proper selection of rock types, the student may obtain a satisfactory basis of thin-section petrography within a semester." The reviewer feels that a year's course work would be required to cover the book adequately.

The book is divided into three parts: Part One, Igneous Rocks (Williams); Part Two, Metamorphic Rocks (Turner); and Part Three, Sedimentary Rocks (Gilbert).

Part One begins with a discussion of principles of petrology, which is followed by a study of textures and an introduction to the classification of igneous rocks. The treatment of petrogenesis is brief, concise, and excellent. Bowen's reaction series, although modified according to Barth, could have been brought up-to-date, with the inclusion of some of the more recent observations. In basic intrusives, for example, soda enrichment in plagioclase is accompanied by iron enrichment in pyroxenes, and this relationship is more strongly marked throughout the major part of crystallization than is apparent from the Bowen diagram, which stresses the discontinuous reaction in the mafic minerals. Thus by the time andesine has formed in the plagioclase series iron-rich orthopyroxene rather than hornblende has taken the place of magnesian orthopyroxene. Additional examples could be cited to illustrate the need for revision of the classic Bowen diagram.

The treatment of textures is complete and well organized and contains more than is required in an elementary course. One is apt to forgive the student who has temporarily forgotten the meaning of diktytaxitic or bostonitic texture, or of axiolites. The nomenclature and classification outlined by the author sum up the SiO_2 content and the Si- and Al-saturation principles as well as norms, modes of occurrence, and textural and quantitative mineralogical classifications. The classification based on SiO_2 content follows Hatch and Wells. Rocks with more

than 66 per cent SiO_2 are called acid, those with 52 to 66 per cent intermediate, those with 45 to 52 per cent basic, and those with less than 45 per cent ultrabasic. The use of the numbers 66 and 52 gives an appearance of precision which is deceptive. The average compositions of pyroxenites, which everyone considers to be typical ultrabasic rocks, are as follows:[1] pyroxenite with augite, 48.9 per cent SiO_2; with rhombic pyroxene, 54.7 per cent; with two pyroxenes, 51.8 per cent; with olivine, 45.0 per cent; average pyroxenite, 50.5 per cent. This compares with an average gabbro composition of 48.4 per cent SiO_2 and an average diorite of 51.9 per cent. Although Hatch and Wells in their 1926 edition wisely discarded the SiO_2 content principle when it comes to ultrabasic rocks, Williams extends it to include them. In their 1949 edition Hatch and Wells no longer define "acid," "intermediate," and "basic" in terms of stated ranges of silica percentage. The reason for this is made obvious by reference to Williams. An elementary student wishing to know the meaning of "basic igneous rock" is referred in the index to the definition setting out a silica content of 45 to 52 per cent. Chapter four discusses the alkali gabbro clan, which is considered the clan of "alkali-rich basic igneous rocks." Some of the rocks included in that group have the following average SiO_2 content: nephelinite 39.0 per cent, melteigite 41.9 per cent, ijolite 42.6 per cent, urtite 42.6 per cent, teschenite 45.9 per cent, and italite 52.3 per cent. The terms "acid" and "basic" remain invaluable, but it is not possible to cramp them into narrow limits of silica percentages. No silica-percentage limit can be chosen which will separate all "basic" from all "intermediate" and all "ultrabasic" rocks.

The authors state in the preface that the book is concerned more with the description of rocks than with problems of genesis, yet in the organization of Part One genetic principles serve as a guide to the succession of the chapters. Thus fine-grained igneous rocks precede coarse-grained rocks, and basic rocks precede acid rocks. Whatever the logic of such an arrangement, coarse-grained rocks are easier than fine ones to identify, and the mineralogy of granites is simpler than that of alkali-rich basic rocks. From the point of view of the teacher the old established sequence of treatment is still the best.

The descriptions of the various igneous rocks are complete, well arranged, and logically presented. Although one could enquire why the lamprophyres are lumped with the ultrabasic rocks and why the gabbro clan should precede the ultramafic clan in Williams' reversal of the customary order of treatment, from the point of view of quality and completeness of the rock descriptions this part of the book ranks with the best textbooks that have been written on igneous petrography. Unfortunately a newcomer to petrography will not appreciate the wealth of varietal names cited. Zirkel in one of his early books used 66 rock names, Harker mentioned just over 100 in his fifth edition, and Hatch and Wells cited 120 in their eighth edition. In recent years the trend in systematic igneous petrography has been towards simplification in nomenclature. A hasty count of Williams' chapters has yielded a crop of over 160 names, which include, among others: forellenstein, mafurite, ugandite, madupite, katungite, uncompahgrite, cedricite, orvietite, and others similar. This will hardly stimulate an elementary student's interest in the subject.

[1]Nockolds, S.R., 1954, Average chemical compositions of some igneous rocks: Geol. Soc. America Bull., v. 65, p. 1007–1032.

Part Two, on metamorphic rocks, is similar in organization to Part One. A discussion of processes of metamorphism is followed by a study of textures and in turn by an introduction to the concept of metamorphic facies and classification. The other subdivisions are: hornfelses and spotted slates; cataclasites, mylonites, and phyllonites; slates, phyllites, and schists of low metamorphic grade; and high-grade schists, amphibolites, granulites, and eclogites. Important metamorphic rocks that have not been listed include quartzite and epidosite. This part of the book stresses petrogenesis very heavily, more so than would seem necessary. The approach to the study is modern, the style is fluent, and with the aid of the excellent illustrations a student can get a good foundation in the nature and character of metamorphic rocks. The classic European localities still loom high among the illustrations. Europe is represented by about 52 per cent of the rock sections illustrated, California—the author's home state—by about 29 per cent, the Far East—notably New Zealand—by 17 per cent, the United States (except California) and Canada by about 11 per cent, others by 2 per cent. The impressive list of donors of material includes, among others, some of the foremost European petrographers. In the preface, incidentally, Dr. Wallace S. Pitcher's name has been inadvertently changed to Walter Pitcher.

The subdivisions in Part Three, on sedimentary rocks, are: origin, composition and texture, sandstones, argillaceous rocks, calcareous rocks, and miscellaneous sedimentary rocks. Because of the genetic relationship of many igneous and metamorphic rocks a discussion of metamorphic petrography precedes that of sedimentary petrography. In a book which is concerned more with rock descriptions than with genetic problems the value of such a sequence is questionable. For the student an understanding of sedimentary petrography may be a valuable prerequisite to his study of metamorphic petrography. The treatment of sedimentary rocks is exhaustive, the descriptions are excellent, and much new material is presented. Carbonaceous rocks have been omitted entirely, and no descriptions are given of bauxite, chalk, and travertine.

In summary, the book is well organized, competently written, and exceptionally well illustrated. The numerous excellent drawings of rocks in thin section, mostly by Williams, are the most conspicuous single feature of the book. The book will probably serve as the most useful single-volume guide yet published in the United States to the study of rocks in thin section. Congratulations to authors and publisher!

GERALD M. FRIEDMAN

Talvey Metal Mines Limited
Sault Ste. Marie, Ontario, Canada

Geology of Petroleum. A. E. Levorsen. x and 703 pp. W. H. Freeman and Co., San Francisco, 1954. $8.00

Geology of Petroleum by A. E. Levorsen differs from other textbooks on petroleum geology in just the way the title indicates. It emphasizes the geological environment in which oil occurs rather than the techniques by which it is found. The result is excellent.

The book is divided into five parts. Part one is introductory and also contains a general discussion of the occurrence of petroleum. It includes modes of surface and subsurface occurrence and both stratigraphic and geographic distribution of petroleum.

Part two, "The Reservoir," discusses both the reservoir rock and the trap. An excellent chapter on reservoir pore space is included in this part, though much of the subject matter is also closely allied to part three, "The Petroleum Pool." Three chapters are devoted to reservoir traps—general and structural traps, stratigraphic traps, and combination and salt dome types. These are authoritative, well organized, and contain much new material.

Part three, "The Petroleum Pool," has three chapters, dealing with reservoir fluids, reservoir conditions, and reservoir mechanics. Add to these part two, "The Reservoir," especially the chapter on reservoir pore space, and the result is a very good review of reservoir geology.

Part four, "The Geologic History of Petroleum," includes origin, migration, and accumulation of petroleum. It presents the material from a functional rather than a theoretical point of view. In the opinion of the reviewer, it represents a strong advance in the treatment of these subjects.

Part five, "Applications," deals with subsurface geology, presenting a group of techniques; the petroleum prospect, a judgment of value based on techniques; and the petroleum province, which is a fundamental of petroleum occurrence. It would appear to be more consistent with the main thesis of the book to devote less space to the first two chapters and to increase the treatment of provinces, sub-provinces, and trends. These are not only essential and distinctive features of oil occurrence, but this is a field in which the author is better known than any other geologist. The chapter on the petroleum province has good parts, such as the section on wedge belts of permeability, but a much fuller treatment of the whole subject would be useful.

The supplementary features of the book are very well done. The illustrations are designed with attention to subject matter and elimination of unnecessary detail. They are well drawn and printed clearly.

Each chapter is followed by a list of selected readings, and by an extensive bibliography. Each bibliography is arranged numerically according to citations in the text. It would be useful if somewhere in the book there were an alphabetical list of authors with cross-reference to the chapter bibliographies.

A spot check of the 30-page index shows it to be useful. For example, under "pressure" there are 89 classified references; "porosity" has 74, and "permeability" 67. To have the main reference or definition placed in bold-faced type would be helpful.

The style of writing is easy to read, neither too condensed nor too expanded; there are interesting changes of pace, and the reasoning is easy to follow.

The format is pleasing and is similar to that of other books in the geological series published by W. H. Freeman and Company and edited by James Gilluly and A. O. Woodford.

In summary, *The Geology of Petroleum* is well conceived, well organized, and outstanding in most of its parts. These include "The Reservoir," "The Petrol-

eum Pool," and "The Geologic History of Petroleum," which together occupy 520 of the book's 703 pages.

The book probably will be very popular among practicing petroleum geologists, particularly those who do not have a good grounding in reservoir geology. As a college text it is highly recommended for those who prefer to emphasize fundamentals.

SHEPARD W. LOWMAN

Rensselaer Polytechnic Institute

TRANSACTIONS OF THE ASSOCIATION OF GEOLOGY TEACHERS

PROGRAM OF 1954 ANNUAL MEETING. For its 1954 annual meeting the Association of Geology Teachers met on January 28-29, 1955, in joint session with the East Central Section, at the Department of Geology, Ohio State University, Columbus, Ohio. Approximately 60 members were in attendance. A condensed program follows.

Friday, January 28

After a registration and coffee hour, the morning was devoted to a visit to the the extensive research facilities of the Battelle Memorial Institute. The group lunched informally at the Ohio Union. A symposium, "Geology on TV," followed at Orton Hall. The moderator was Richard M. Mall of the Department of Speech at Ohio State. Speakers and topics were as follows: W. H. Parsons: "Gemology on TV–Wayne University Experiences"; J. H. Zumberge: "University of Michigan Programs"; and W. H. Ewing of Ohio State's station WOSU: "Educational TV and Geology." There was considerable lively discussion.

The annual business meeting followed (see minutes below). The afternoon program was concluded by a slide symposium, at which eight members presented Kodachromes.

At the banquet, on Friday evening at the Ohio Union, the Neil Miner Award was presented to William H. Shideler of Miami University, the citation being read by Edmund M. Spieker; a memorial scroll to Ralph E. Digman, which is to be presented to his family, was read by Milton T. Heald, out-going secretary; announcement was made of the election of John L. Rich of the University of Cincinnati to honorary membership in the Association; and the secretary was instructed to send greetings to President Leland Horberg, who was unable to attend the meeting. In his absence his address, "Current Trends in Geology and Their Relations to Geological Education," was read by Vice President John B. Lucke.

Saturday, January 29

The morning was devoted to a symposium, "Expanding Enrollments–What They Mean to Geology." R. B. Thompson, Registrar at Ohio State, presented an

illustrated talk on expanding enrollments in general; C. A. Lamey spoke on "Future Space and Staff Needs of the Ohio State Geology Department"; and R. H. Mahard gave a paper on "The Problem of the Geology Major in the Liberal Arts College."

There was then a general discussion of recent changes in the procedures for certification of Ohio teachers of high-school science. The group was addressed by Dr. C. E. Ronneberg of Denison University and by Dr. J. R. Richardson of Ohio State, both of whom were members of the committee that drafted the revised certification in "Comprehensive Science." After extended discussion, the meeting went into business session to pass a resolution regarding the place of Earth Science in such certification.

The 1954 annual meeting then adjourned.

ROBERT L. BATES, *Secretary.*

MINUTES OF THE 1954 ANNUAL BUSINESS MEETING OF AGT. The 1954 annual business meeting of the Association of Geology Teachers was held at Orton Hall, Ohio State University, Columbus, on January 28, 1955. The meeting was called to order at 3:45 P. M. by Vice President John B. Lucke, who presided in the absence of President Leland Horberg.

Chairman Freeman Foote of the Nominating Committee announced the election of the following officers for 1955:

President: William H. Shideler, Miami University
Vice President: Stanard G. Bergquist, Michigan State College
Secretary: Robert L. Bates, Ohio State University
Treasurer: Charles G. Higgins, Jr., University of California at Davis

The meeting was opened for nominations to the Committee on the Neil Miner Teaching Award, which committee consists of the president, past-president, secretary, and three elected members. The following were nominated: Freeman Foote, Williams College; Robert W. Webb, University of California at Santa Barbara; Charles B. Moke, College of Wooster. It was then moved, seconded, and unanimously passed that the nominations be closed, and the above candidates were declared elected.

The members were reminded that during the year 1954 the Association was admitted to full membership in the American Geological Institute and became affiliated with the American Association for the Advancement of Science.

The final financial statement of William F. Read, editor of the *Journal of Geological Education* 1951-53, was distributed in mimeographed form.

Anastasia Van Burkalow, editor of the *Journal of Geological Education*, commented on the present status and anticipated future of the *Journal*, including particularly the need for wider distribution. She moved that the national dues be increased from $1.00 to $2.00, and that a subscription to the *Journal* accompany every membership. The motion was seconded and a discussion followed. It was pointed out that the total annual dues would become $3.00 (the proposed new figure plus $1.00 sectional dues); that the editor expects to start including abstracts of articles printed in the *Journal*, so that they can be included, when suitable, in future issues of *Geological Abstracts;* and that the *Transactions* of the Association would be discontinued as a separate series and would be incorporated into

the *Journal* . Miss Van Burkalow's motion was then put to a vote and was passed without opposition.

Richard H. Mahard distributed copies of a report on recent changes in the procedures for certification of Ohio teachers of science, with the request that the members read it and consider action later in the meeting.

Kurt E. Lowe distributed a progress report on the program of the American Geological Institute's Committee on Education and Public Relations, particularly the education group of this committee, of which he is sub-chairman. Discussion followed. Lowe pointed out that the AGT is to assume full sponsorship of the AGI's directory of *Departments of Geological Science in. . .the U. S. and Canada* and that S. W. Lowman has accepted responsibility for revision of the directory. Lowe then moved that the section editors of AGT and two members appointed by the president constitute a committee to advise on this project. The motion was seconded and passed.

Robert L. Bates stated that the present system of canvassing the full membership for nominations for the Neil Miner Teaching Award was unwieldy, owing to increased membership, and pointed out that similar awards made by other societies are made on the recommendation of a special committee set up for the purpose. He then moved that the recipient of the Neil Miner Award be selected by the Award Committee, with the understanding that the Committee would welcome and consider suggestions from the membership. The motion was seconded and passed.

Milton T. Heald stated that the following change in the Association's constitution would shortly be submitted to the membership for action by mail ballot:

Article VI—Executive Committee

The elected officers of the Association, the last past-president of the Association, (and one accredited representative from) *the president of* each section of the Association, *and the Association representatives to the American Geological Institute and the American Association for the Advancement of Science* shall constitute an Executive Committee . . .

(In the above, material to be deleted is in parentheses and proposed additions are italicized.)

The minutes of the last annual meeting were approved as distributed.
The annual report of the treasurer (see below) was accepted.
The meeting adjourned at 5 P.M.

* * * * * * * * * * *

The business meeting was re-convened at 1:15 P.M. on January 29, 1955.

After extended discussion of the place of Earth Sciences in the high schools and in the preparation of high-school science teachers, especially in Ohio, Richard H. Mahard made the following motion: "It is the sense of this meeting that Earth Sciences should be added, on a par with Physics, Chemistry, and Biology, to the 'Comprehensive Science' program for certification of Ohio science teachers." The motion was seconded and after some discussion was passed.

The business meeting was finally adjourned at 1:30 P.M.

Respectfully submitted,

ROBERT L. BATES, *Secretary*

TREASURER'S REPORT. The following is the financial statement through January 17, 1955:

RECEIPTS:

Balance on hand November 2, 1953		$ 227.53
National dues from New England Section		59.00
" " " " Eastern Section		111.00
" " " East Central Section		90.00
" " " Central Section		103.00
" " " Southeastern Section		23.00
" " " Far Western Section		68.00
" " " National members		11.00
Journal of Geological Education (subscriptions)		802.10
		$1501.63

DISBURSEMENTS:

To Anastasia Van Burkalow (Editor)		
Printing of *Journal of Geological Education*, Vol. 2. No. 1		$ 291.00
Postage, shipping charges, envelopes	$47.79	
Less profit from sale of extra copies of Heald's "Periodic Table"	6.30	
	$41.49	$ 41.49
To Gerald M. Friedman (Treasurer)		
Digman funeral (flowers)		11.25
Stationery		13.55
Check book		2.00
Rubber stamp		2.50
Telephone call		1.60
Stencils, envelopes, postage, help, and mimeographing		56.34
To Milton T. Heald (Secretary)		
Transactions I		41.15
Transactions II		57.05
Stationery		20.20
Paper, stamps, ink, postage, help, stencils		67.55
To Southeastern Section		
Postage (refunded by national AGT)		1.40
		$607.08
BALANCE ON HAND		$894.55

Respectfully submitted,

GERALD M. FRIEDMAN, *Treasurer*

Editorial note: The bill for printing Vol. 2, No. 2 of the *Journal of Geological Education* ($300.00) had not yet been received by the treasurer as of the date of this statement.

NOTES AND NEWS

SOUTHEASTERN SECTION. By mail ballot the AGT members in the southeastern states have elected the first officers of the section, whose names are printed on the inside back cover of this issue of the *Journal of Geological Education*. This makes the sixth organized section of AGT. A hearty welcome to it.

THE NEW YORK STATE GEOLOGICAL ASSOCIATION will hold its 27th annual meeting and its 30th anniversary at Colgate University, Hamilton, New York, on May 13-14, 1955. Four field trips are planned, to visit Upper Silurian and Lower and Middle Devonian outcrops and to study the geomorphology and Pleistocene geology of the Upper Chenango River area. Leaders will be G. Arthur Cooper, John E. Woodruff, L. V. Rickard, and D.W. Trainer. After the annual dinner there will be a symposium on the Devonian of North America and of New York in particular, with W. Storrs Cole as chairman and G. Arthur Cooper, Donald Fisher, and A. Scott Warthin, Jr., as speakers. Those desiring further information about this organization should write to its permanent secretary, Kurt E. Lowe, Department of Geology, The City College of New York, New York 31, New York.

CONSTRUCTION OF CRYSTAL MODELS. Gerald M. Friedman reports the following paper, nicely illustrated, on the construction of crystal models for teaching purposes:

Vicaire, P., 1954, Sur la construction des modèles cristallines: Bull. Soc. française Minéralogie et Cristallographie, v. 77, p. 1410-1417.

Those of our readers who do not have regular access to foreign periodicals will surely welcome such references from their colleagues. Let us hear about any of your foreign-literature "finds" that might be useful to other geology teachers.

ROBERT BALK. With the death of Robert Balk in a plane crash in February all geologists suffered a great loss. To readers of the *Journal of Geological Education* one part of this loss is the paper he had promised but had not yet had time to write for us. Two days after the crash the editor of the *Journal* received an unsolicited card assuring her he had not forgotten the paper. "Please be patient," he concluded. "I won't default!"

WORK OF THE AGI. The Education Committee of the American Geological Institute has recently prepared a statement about the Institute's work. To members of AGT the following specific activities, as described in the report, may be of special interest:

1. Correspondence with high school students and high school guidance counselors, cooperation with the National Science Teachers Association, and stimulation of education and public relations activities by local and member societies.

2. Working through the Scientific Manpower Commission, which the Institute helped to create, to improve the selective service regulations and to improve the opportunities for geological work in the military service; publication of military service instructions in the NEWSLETTER; efforts to have the USGS wartime intelligence folios declassified so copies can be placed in college libraries; correspondence with students and draftees regarding selective service regulations and opportunities for geological work in service.

3. Efforts to encourage universities and colleges to announce their vacancies through the GEOLOGICAL NEWSLETTER. As a result of this successful effort the Institute has rendered a direct assist in filling more than 30 vacancies in the last 6 months.

Other tangible accomplishments of the Institute are: *Geological Abstracts; Geological Newsletter;* a career booklet for high-school students, "Shall I Study Geological Science?"; the directory of *Departments of Geological Science in . . . the U.S. and Canada,* to be issued in the future by AGT for AGI; a *Glossary of Geologic Terms,* to be ready for publication this year.

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